Supplementary material

Vegetation class	IGBP classes included	Latitude
Tropical forests	2	-20° < lat ≤ 20°
Temperate forests	1, 2, 3, 4, 5	lat ≤ -20° & 20° < lat < 55°
Boreal forests	1, 2, 3, 4, 5	lat ≥ 55°
Savannas	8, 9	lat < 55°
Shrublands	6, 7	lat < 55°
Grasslands	10	lat < 55°
Croplands	12	-

Table S1. Classes of vegetation defined by homogeneous IGBP land cover classes and latitude.

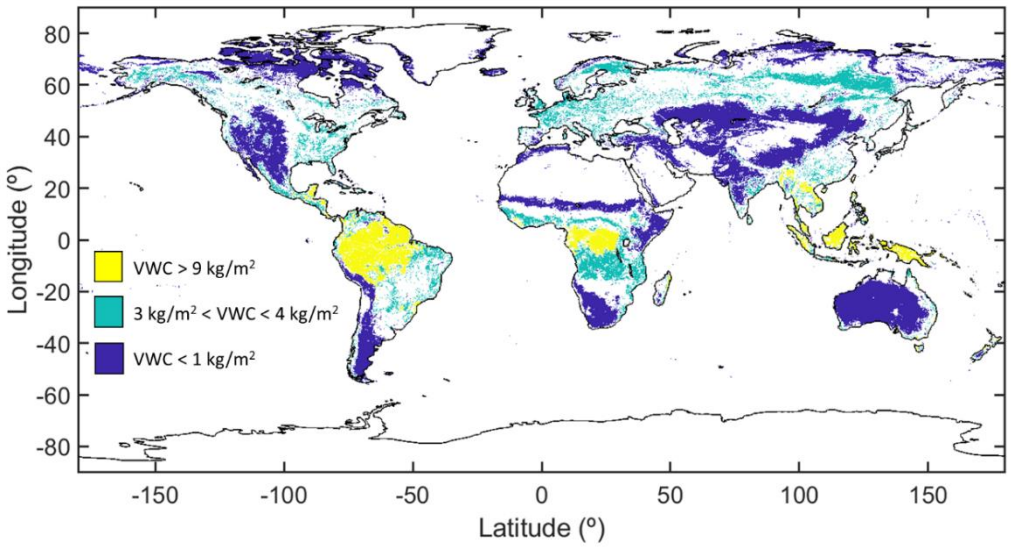

Figure S1. Classes of VWC studied in Figure 3. Yellow: VWC>9 kg/m^2; light green: VWC between 3 and 4 kg/m^2; blue: VWC<1 kg/m^2.

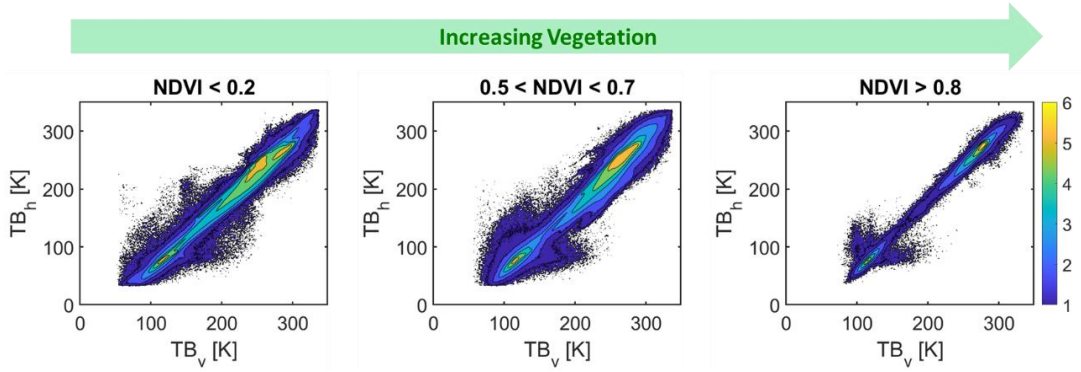

Figure S2. Comparison of SMAP brightness temperatures at vertical (TBv; x-axis) and horizontal (TBh; y-axis) polarizations for increasing NDVI: 0-0.2 (left); 0.5-0.7 (center); and >0.8 (right). The color bar shows the density of pixels (decimal logarithm of the number of pixels).

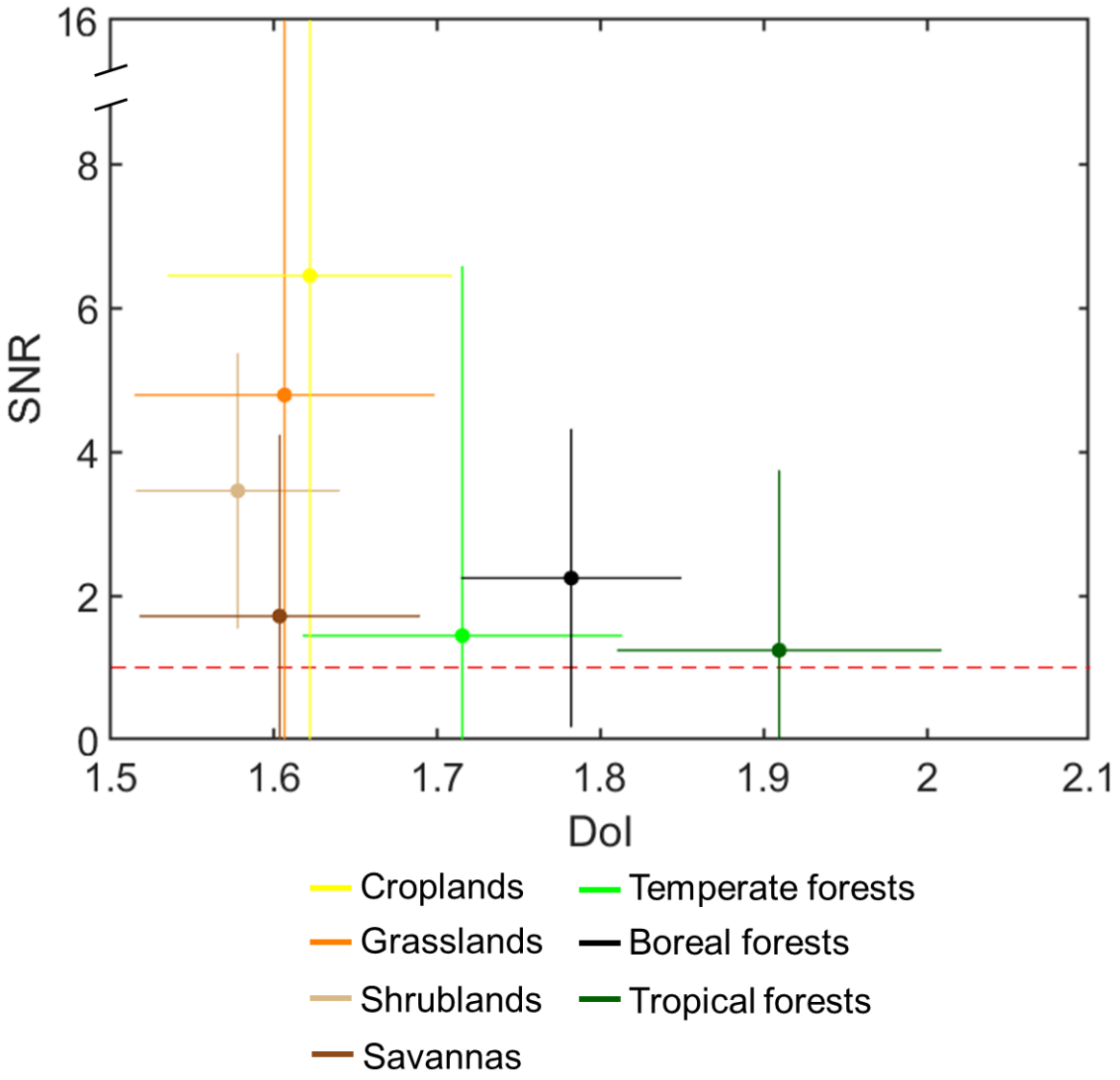

Figure S3. Relationship between DoI and SNR per vegetation classes defined in Table S1. Central dots are median values of each class and variable, and notches represent ±1 std (cropped at SNR=0 in some classes). The red dashed line represents equal contribution from signal and noise (SNR=1).

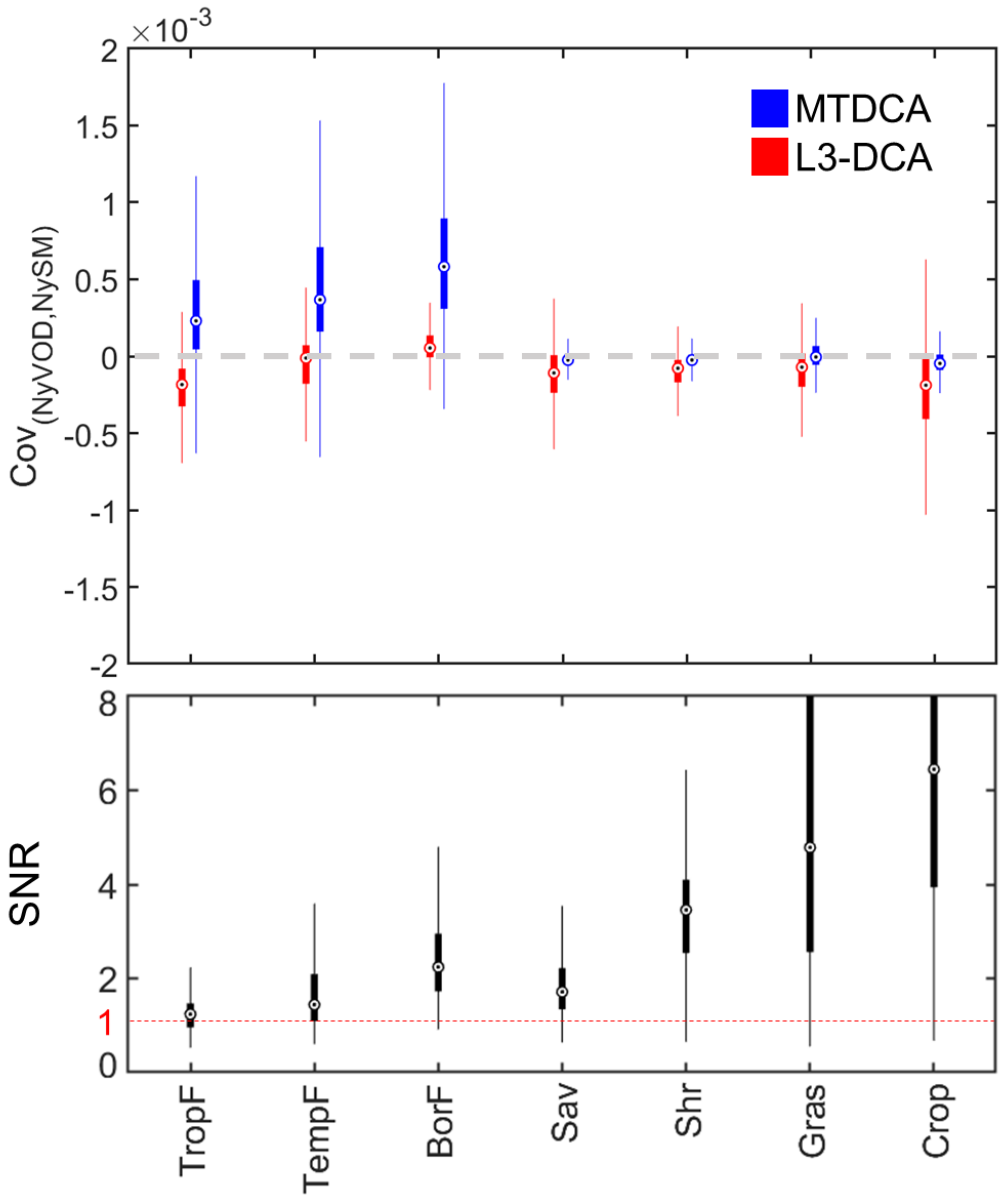

Figure S4. Top panel: Covariance between Nyquist VOD and Nyquist SM per product (blue: MTDCA; red: DCA) and vegetation classes (Table S1). Bottom panel: SNR by vegetation classes (Table S1). A zoom to SNR between 0 and 8 has been applied to ease visual interpretation. Vegetation classes are: tropical forests (TropF), temperate forests (TempF), boreal forests (BorF), savannas (Sav), shrublands (Shr), grasslands (Gras), and croplands (Crop). The red dashed line in the bottom panel represents equal contribution from signal and noise (SNR=1).

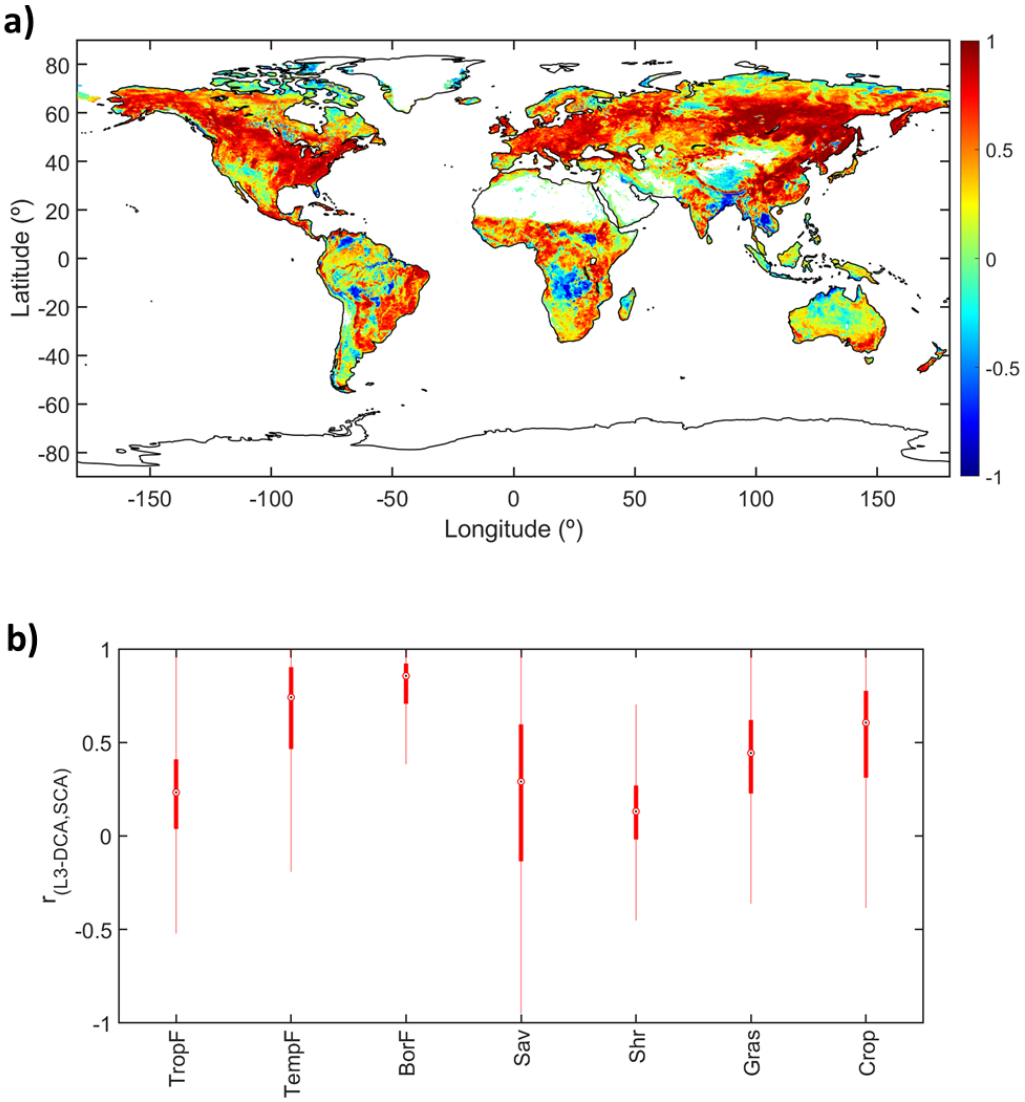

Figure S5. a) Map of the correlation between the L3-DCA VOD and its prior within the Tikhonov regularization. This prior dataset is the NDVI-based VOD used as an input for SCA soil moisture retrievals; b) Boxplot showing the same correlation by vegetation classes defined in Table S1. High positive correlations can occur if too high of regularization is applied in the Tikhonov regularization, which constrains L3-DCA VOD variations to be the same as the SCA VOD variations.